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ABSTRACT

This publication contains an encapsulated report on a 1973 pilot project on computer aided bus routing and scheduling involving 22 diversified school districts of New Jersey. Called Transportation Information Planning Service (TRIPS), the project sought to develop and subject to initial test a man-machine system that would offer optimum latitude in tailoring services to satisfy the particular needs of individual school districts, while at the same time taking the best possible advantage of the potential benefits of the large-scale computer. Project success was measured in terms of the safety, effectiveness, and economy of operation. The pilot study showed the major beneficiaries of the system to be the transportation supervisors in the respective local school districts. It also demonstrated the practical viability of an ongoing working relationship between the local transportation supervisor and his or her staff on the one hand, and on the other, transportation and computer specialists from a large and diversified service agency. A list of references is provided. (Author/MLP)

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PR-74-13

Transportation Information Planning Service

# Trips

## A PILOT TEST TO IMPROVE SCHOOL BUS ROUTES AND TIME SCHEDULES

Thomas R. Ronchetti
Bruce L. Taylor
Wesley W. Walton

In Preparation for the Opening of Schools in September 1973

June 1974

EA 006 281

EDUCATIONAL TESTING SERVICE
PRINCETON, NEW JERSEY

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Trips
Transportation Information Planning Service

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# A Pilot Test to Improve School Bus Routes and Time Schedules

Thomas R. Ronchetti
Bruce L. Taylor
Wesley W. Walton

A Report on the Development and Pilot Test in 1973 of a System to Enhance the Safety, Effectiveness, and Efficiency of School Transportation through Computer-Aided Bus Routing and Scheduling.

for the Division of Field Services
New Jersey State Department of Education

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Trips

Transportation Information Planning Service

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**Trips**

**Transportation Information Planning Service**

*The tasks described in this report were performed by Educational Testing Service (ETS) in 1972-73 pursuant to Control No. 17384, Account No. 31105-500-152-806-02, Commodity Classification: Computerized School Transportation Scheduling, New Jersey Department of Education. The work was undertaken in partial implementation of recommendations by the Governor's Management Commission in 1970 and 1971.*

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# FOREWORD

*In these pages is a somewhat encapsulated report on a pilot project on computer-aided bus routing and scheduling, undertaken on behalf of the Division of Field Services, New Jersey Department of Education by the Educational Testing Service. Called TRIPS, the project sought to develop and subject to initial test a man-machine system that would offer the people in the system optimum latitude in tailoring services the system afforded in ways that would satisfy the particular needs of individual school districts, while at the same time taking best possible advantage of the potential benefits of the large-scale computer.*

*The pilot study showed the major beneficiaries of the system to be the transportation supervisors in the respective local school districts. It also demonstrated the practical viability of an ongoing working relationship between the local transportation supervisor and his or her staff on the one hand, and on the other, transportation and computer specialists from a large and diversified service agency such as Educational Testing Service (ETS). The close teamwork between the individual school district personnel and the ETS staff, together with substantial aid at judicious points in the process from the computer, appeared to be a nearly ideal way to invoke the computer as a significant aid in the pursuit of tasks in the areas of school management and educational administration.*



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*Although the essence of the work in 1973 is thought to have been captured in these pages, there will doubtless be cases where more comprehensive explanations than given here will be required. Where fuller documentation would be of interest, the reader should request* Possible Educational, Safety, and Economical Benefits of School Bus Scheduling, *160 pages, the final report on the pilot project.*

*It is also possible that readers will be interested in having information on more recent TRIPS developments than reported here before those get into general circulation. At the time of this writing, TRIPS 1974--in preparation for the opening of schools in September 1974--is well on its way. It is more than twice the size of the 1973 operation. TRIPS '74 is looked upon here as a field test of an improved system that has gained the benefit of the formative evaluations done last year. Formative evaluations will again be completed in 1974, leading to further improvement and refinement in the TRIPS system. As well, the beginning elements of summative evaluation will be assembled. On the basis of the findings, the long term viability of the system may be established.*

*Various and varied-purpose presentations--in print and for use on screen--are in preparation reporting on TRIPS and TRIPS-related developments, for it is thought to be important to enable wider and more complete understanding of what the system will and will not do. Inquiries of a general nature or pointed to specifics in computer-aided bus routes and schedules will receive careful and prompt attention. Correspondents are invited to be as specific as possible in making their interests known so that material sent in response to inquiries may prove to be as helpful as possible.*

*Wesley W. Walton, Ed.D.*

*May 1974*

**Trips**

**Transportation Information Planning Service**


*Abstract*

*During 1972-73, Educational Testing Service collaborated with the New Jersey Department of Education and twenty-two diversified school districts of the state in a 15-month pupil transportation pilot project. The project set out to develop and subject to pilot test a computer-aided system for constructing bus routes and time schedules for use in the transportation of pupils to and from public and private schools. Preliminary tests of the systems' concept showed favorable odds that its wide application could lead to widespread and significant improvements in pupil transportation programs. But first, the viability of the system would have to be demonstrated.*

*The purpose of the pilot, then, was to estimate the systems' possible economic benefits, and to assess its efficacy for wider field test. Ultimately, if pilot and field tests provided sufficient verification evidence, the system would be put into operational use on a large scale basis in pursuit of its major goal: improvement in the transportation of school children. The system was given the name TRansportation Information Planning Service (TRIPS) and the pilot test was designated TRIPS '73.*

*Three criteria were established on the basis of which to measure success.*

- *TRIPS '73 would have to be safer. It should be able to demonstrate a reduction in hazards to safety while children are in transit between home and school--on foot and in vehicle.*

- *TRIPS '73 would have to be effective. It should afford the transportation director full control and regulation of the operation, make it feasible to fulfill transportation goals, policies, and positive practices, while at the same time avoiding unsafe conditions, duplication of effort, and waste of resources.*

- *TRIPS '73 would have to be efficient. It should result in fewer live load miles per route, closer approximations of bus load limits per trip, shorter average elapsed times in transit, better bus fleet utilization, better use of the road network, and reduction in numbers of routes required. It should save miles, minutes, gallons, and dollars.*

*Although the pilot project was not without its problems, and even though some problems could not be resolved, TRIPS '73, on balance, was a success on all counts. Findings (see in particular pages 5 to 9) were sufficiently positive to justify launching TRIPS '74 with twice the*





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*Abstract*
*(Continued)*

*number of districts participating.*

*TRIPS '74, engaging forty-four diversified school districts, and involving refinements of procedure and further development of systems, programming and computer support, is in progress as this is written. In major respects, as a consequence, parts of this report are more historical than descriptive of the TRIPS system. Nonetheless, it does provide an important perspective at a crucial period in the evolution of this means for putting the large scale computer to work as an aid in the solution of an important school management problem.*

*Title:* *A Pilot Test to Improve School Bus Routes and Time Schedules*

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## INTRODUCTION

One who looks with complete objectivity for ways to improve the administration and management of the schools soon will settle upon pupil transportation as one area in which substantial and significant gains can be realized. Looked at either within a single school district or in a larger frame of reference--for example, as a county, regional or even statewide problem--systematic moves to improve both effectiveness and efficiency in the movement of pupils to and from schools might set out to accomplish an easy to state but hard to achieve set of objectives. The best of all possible ends to be realized would be to transport pupils in the shortest amount of time, using the smallest number of buses and the fewest gallons of fuel, but, to transport the children in such a way that they are afforded the maximum amount of personal safety.

It would seem to be reasonable in dealing with this kind of administrative improvement that a straight line relationship would be found to exist between the size of the geography and population encompassed on the one hand, and on the other, the size of the improvements that could be reasonably expected to occur. That is to say, the gains should be expected to be greater in larger school districts. Gains also should be expected to be large in consortia of school districts, contiguous smaller districts able to join forces in order to serve larger numbers of pupils with smaller numbers of buses.

Motivations to achieve improvements such as these were in the background of a course of action recommended in 1970 and again in 1971 by the Governor's Management Commission in New Jersey, the Commission's 1971 expections being that, among other advantages, annual savings of at least $660,000 would be realized when feasible statewide improvements in school bus scheduling and routing were put into effect.

Work was underway by spring of 1972 to advance these objectives under the aegis of the New Jersey State Department of Education, with technical support furnished by the Educational Testing Service (ETS). During 1972-73, a 15-month pilot project was executed. ETS implemented a pupil transportation management system with computer-aided bus scheduling and routing called TRIPS in twenty-two school districts of varying size and character. Eighteen of the districts were successfully scheduled through the system, each with savings. The four districts that were not, wanted another opportunity to work with the system, if such an opportunity were afforded another year.

During 1974, a ten-month systems refinement and advanced application effort was mounted to extend the TRIPS system developed by ETS to all the twenty-two original districts, and in addition to twenty-two more districts in the state. Thus, when the schools open in the fall of 1974, forty-four districts in the State of New Jersey will have participated with ETS in a cooperative task to make substantial and significant improvements in the safety, effectiveness and efficiency of the operation of their respective pupil transportation programs. This effort, as with the pilot project in 1973, will be the largest-scale operation of computer-assisted bus scheduling in the United States. The dramatic successes of 1973 give clear assurance that the TRIPS man-machine system functions well. Planned improvements for introduction into TRIPS '74 will assure that the problems that were encountered the first time 'round will not occur again.

In the paragraphs that follow, we have summarized the lessons that have been learned as a result of the pilot project, first from the point of view of the goals and objectives that were set for the task, second from the standpoint of the effectiveness with which the goals and objectives were or were not achieved, and finally in terms of refinements: those respects in which TRIPS needs to be subjected to further improvement so that its fullest possible potential may be realized.

## GOALS AND OBJECTIVES

Traditionally, the task facing the pupil transportation director in a school district is to produce one workable solution to the problem of moving children for whom the district provides transportation to and from school. Time constraints usually necessitate limiting the task to a once-only operation, for in the usual circumstance, figuring out one scheme will use up the summer months which is what the transportation director has to complete the work with his or her maps, pins and lists.

A major objective in the TRIPS '73 pilot project was to learn how to arrange for the computer to aid the transportation director so that he or she might choose the best solution to the pupil transportation routing and scheduling problem from among a number of possible solutions available. One characteristic that distinguished TRIPS from other efforts to employ the computer in scheduling school buses was that large numbers of districts were served concurrently in this fashion, enabling each district to seek its own optimum solution out of a number of tailored solutions processed through the computer. It was expected that, within this double-pronged context of large scale multiple-district operation and individual district tailored service, demonstration of both substantial dollar savings and significant gains in the quality of bus services would be possible. But it obviously had to be as much a man as a machine system.

The setting in which TRIPS will be found to be imbedded, as a consequence, embodies all the management requirements in the total pupil transportation process. It is regarded as essential, for example, that the major ends to be gained by the tasks of routing and scheduling buses concern not only pupil loads, times of stops, bus trips, gallons of fuel, important as these are, but also less quantifiable outcomes such as elimination of hazards, increased safety, more effective ties between bussing and educating, and improved management information for decision

making. Another management requirement for the system was that it have within it sufficient flexibility to enable the transportation director to "call the shots" at major decision points. Having the computer to do the bus scheduling and routing job for the transportation specialist was not one of the project's objectives. Rather, the mission was to evolve a workable set of actions and interactions involving transportation and computer experts at ETS, transportation directors in the respective school districts, and at key points in the process to put the computer to work where its help might prove to be particularly useful in doing repetitive and tedious parts and the highly complicated time-consuming parts of the work to be done.

Criteria against which success of the pilot project could be measured were established in terms of three operational objectives: safety, effectiveness, and economy. Explicit and measurable definitions were given to each objective to assure agreement in advance on how success (or failure) would be ascertained. The definitions were as follows:

> Safety - The extent to which all activities of the pupil transportation program are carried out without subjecting pupils to avoidable hazards. This implies not only the safe conduct of pupils to and from school, but also includes concerns for the time they are required to walk to the bus stop, and the safety and convenience of the bus stop assignments for all the pupils in the district.
>
> Effectiveness - The extent to which resource usage is optimized, and all activities of the pupil transportation program are pointed toward meeting the district and state goals. The emphasis to achieve effectiveness is on regulation and control of the operation so that all efforts expended make a positive contribution toward the pupil transportation program without causing duplication of efforts, wastage of resources, or creation of unreasonable or unsafe conditions for the pupils.

Economy - The extent to which the pupil transportation services are provided at the lowest possible cost consistent with accepted standards of operation.

MEASURES OF BENEFIT

The pilot project demonstrated that measurable operational benefits and cost economies are capable of realization where large scale computer assistance is given to pupil transportation directors in the scheduling and routing of buses. Included among the outcomes that can be expressed in quantitative terms are the following:

- 22 widely varied school districts were concurrently processed by TRIPS including regionalized school districts and combinations of municipalities.
- 1,321 square miles were overlaid with TRIPS transportation networks.
- 285 schools were the terminals in TRIPS generated bus routes.
- 1,540 separate TRIPS bus routes were produced.
- 11,000 live load miles were involved.
- 66,000 pupils were transported.
- 88,000 pupils were included in the pupil data base.
- $4,800,000 was the cumulative pupil transportation budget in the fully participating pilot districts in the previous year.
- $373,000 was the estimated savings--about 7.8%--across the participating districts, when compared to the previous year's transportation budget.

The experience in TRIPS '73 urges use of caution in making too much of these data in interpretations and comparisons, for factors effecting efficiency and effectiveness of bus transportation are numerous and numerical comparisons can be made only with extreme care. For that matter, quantitative comparisons in the pilot districts themselves might not hold up if non-quantifiable factors hold sway. For example, it might be that a new interstate highway would be cut through, new district boundaries drawn, schools newly occupied or vacated, or school board policies significantly changed. "Six fewer bus routes than last year" would have little meaning under such conditions.

With this caution in mind, though, it is significant that at least sixty-eight fewer bus routes were required than pupil population statistics would have indicated to be necessary had TRIPS not been available. The figure of sixty-eight is quite conservative. For in the eight districts which projected "bus route savings," without being more explicit, the saving was reported as one route each. Bus miles saved were not estimated--at that time, the gasoline shortage had not yet been felt--but miles saved would also have to have been significant.

The gains in the TRIPS '73 pilot project, as the foregoing might lead one to expect, have been widely regarded as quite substantial indeed. Dollar savings sought (8%) were very nearly realized (7.8%). Having been a pilot period, however, its experiences helped identify further improvements, refinements, and additional efficiencies. Most of these changes have already been incorporated into TRIPS '74 and the preliminary testing of the new features seem to indicate favorable odds for continuation of the 1973 findings: increased efficiencies including both dollar and fuel savings.

In any case, the more dramatic and useful measures of benefit and effectiveness from TRIPS '73 dealt with those parts of the transportation function not possible to quantify at all. Several examples will illustrate the breadth and depth of these realized advantages.

- Resident side pick-up and drop-off on major arteries and on streets of high potential hazard is an integral part of the TRIPS system that cannot reasonably be coped with using manual methods or small scale computing. This feature alone, and there are others such as safety review of stops and roadways, is judged to have increased substantially the safety factor in the pupil transportation programs scheduled through TRIPS.

- TRIPS has made it possible for transportation directors to "graduate" from pins in maps (obviously approximations of the facts in the situation) to management reports based on comprehensively complete bus stop and pupil data bases. If a route needs to be modified or a bus stop changed, the changes are readily reflected in the upcoming management reports, pupils who are affected and rectifying actions which need to be taken are clearly identified. Then too, the listings of the bussing system by stop, by route, by school, and by student can be reviewed to assure that all anticipated conditions--even last minute changes--are going to be met when the buses roll.

- TRIPS affords the transportation director more than one look at a solution to the bus transportation problem. The pupil data base and bussing parameters in the TRIPS system together with the capacity and speed of the large scale computer have combined to present a number of alternative bus routings and time schedules. The transportation director thus is enabled to function as a decision maker, evaluating the several options, for example, in the "what-if-we-were-to-make-these-changes" game, and choosing from among the possibilities the combination that will serve the transportation needs of the district at that point in time the best.

- TRIPS has provided for an audit by the transportation director of his district's computer-generated routes and schedules prior to the operational run of the management reports and bus passes, all well in advance of the opening of school. The reports used to operate the bus system--manifests for drivers, rosters for principal's office, lists for transportation office, records for superintendent's office, etc., and passes for children,--all are run through the computer after the audit for accuracy and adequacy. As a consequence, the starting records are unmarred by significant changes, albeit last minute changes still do, of course, occur.

- TRIPS has also triggered (a) safety review and discontinuance of vulnerable bus stops, (b) rescheduling and staggering of school opening hours to increase bus utilization, (c) modification of student assignments to schools, (d) exclusion of unsuitable roads for school bus use. Not unimportantly, TRIPS has provided the school district, in many cases for the first time, a top quality school bus operations map. Gains have been both visible and intangible; users are consciously aware of both.

Although user opinions and testimonials contribute little if anything as evidence of program viability, they can point evaluators in directions where evidence of viability may be uncovered. It is interesting in these terms to look at what some of the participants in TRIPS '73 pilot at their own initiative had to say.

> "This year's school bus schedule was the most efficient, accurate and problem-free schedule during my 11-year tenure..... We now have information that we never had before: total route miles, total route time, student pick-up time, student list per stop, student list per bus, and a summary of all route information."

> "Having students and drivers well informed made the first day of school pleasant and for the most part uneventful.... You successfully attacked the two most sensitive areas related to transportation - safety and the expenditure of tax dollars. Resident side pickup reduced significantly the possibility of mishap and the district saved several thousand dollars by elimination of four school bus routes."

Safety and Effectiveness The largest gains in safety and effectiveness came from the new importance of the planning function. To gain the help which the computer afforded, it was essential to know such things as where children live, where buses operate, where roadway dangers are, what relationships exist between and among school sites and road networks, where best bus stops are, and what variations of time schedule are possible. Putting the computer into the picture brought an orderliness and logic to the tasks related to answering such questions as these. More than that, it gave purpose and a new level of importance to early creation and maintenance of computer-generated tools which are valuable to schools in functions other than bus scheduling and routing, tools such as the school census, pupil information data base, bus stops list, and the like.

It became normal procedure to set the stage for scheduling and routing buses months in advance of the time during which finally the scheduling and routing got done. Comfortable lead-times as a consequence were made available to enable both the districts' transportation directors and other school administrators to think about the elements in their respective transportation programs that could yield increases in safety and effectiveness, and also to think about the best possible fit between the transportation program and programs related to the major mission of the schools: the education of the young people in their charge. That the computer supplied the assistance needed to surmount the otherwise time consuming, highly repetitive, and sometimes mind boggling tasks connected with the actual generation on bus routes and time schedules cleared additional time for school district personnel to use in planning for the best possible combination of program elements, and in making safety the top priority as plans progressed.

The significance of the stretch-out in the schedule for evolving the pupil transportation program for the upcoming year will become clear on a brief review of some of the key people-oriented actions, the computer-oriented actions and the man-machine interactions in the TRIPS system. Other documents are available that deal in considerably greater detail with these matters of process and procedure. But here is a thumbnail sketch that may suffice for this limited purpose.

Almost the first step is to generate an accurate, serviceable and usable district map. Probably the keystone document for a district using TRIPS, the map with its overlays has become the operations chart for the pupil transportation program, carrying critical information on the total system, including the physical location of each bus stop, and serving as the base reference in both safety and effectiveness evaluations of stops, routes, and schedules.

A second step, early-on, is the planning, preparation and execution of a network analysis. People who know the roads and others that know the TRIPS system work together to identify roadway limitations, traffic densities, permissable turnarounds, roads to avoid, hazardous segments needing resident side pickup, and the like. Then zones are set, irregularly shaped areas within which bus stops exist, and each zone is encoded. Measurements of road distance are taken between all adjacent zones and the links serve for computer-based network analysis. Distances are stored as are savings from combining two given zones on the same route.

It is also possible to build in and store student locators, so that each residence may be evaluated with respect to its relationship to a given zone. Another array of information stored in the system is a set of bus stop descriptions, sufficiently specific for a bus driver to drive to the stop and a rider to walk to it.

The largest data collection task for districts that lack an ongoing school census is to assemble the constituent parts of a pupil data base: name, address, date of birth, sex, grade, session, transportation status, etc., on each pupil in the system, including those that walk to school. Once done, of course, the pupil data base needs only to be updated on a regular (quarterly) basis. Provisions are made, however, so that last minute changes can be incorporated within a given year and before final bus schedules and routes are run in the computer.

As soon as the master file is established for the pupil data base, an alphabetical list of pupils by grade within school is furnished to the district so that its completeness and accuracy may be ascertained. Special attention is given at this check point to assure that transportation status and bus stop assignments are correct. Updates include changes, additions and deletions within year, and these plus rollovers from grade to grade and from school to school between years. Thus the master file, properly maintained, is a current pupil census file.

The computer-based bus schedule and routing process has a preparatory and a production phase. During the preparation, at least two versions are run based upon accumulations of children at each bus stop, together with one or more combinations of start and delivery times and vehicle load restrictions. These runs, in turn, are subjected to critical review by the district transportation director. At each review point, available options are decided upon and revisions are made to meet local requirements. The transportation director may call for changes in the sequence of bus stops, the deletion of some and addition of other stops, or the reassignment of some pupils from one stop to another one. And of course, changes may be made to the pupil data base -- to correct inadvertent errors or to update the information -- throughout the preparatory period.

At the conclusion of the preparation phase final operational decisions are reached, the most recent run is revised or approved, and parameters for each route are set, including average speed, route destination, and arrival time at the school.

The production phase is then run, reflecting both operational decisions reached and updates made. This run lists each route, its destination, calling sequence, names of pupils at each stop and calling time, the route time and mileage together with pupil load. Several reports to serve a variety of functions both in the transportation and pupil personnel administration areas are printed as part of this step. The various reports are user-oriented, formatted and "polished" for direct distribution to drivers, principals, guidance counselors, attendance officers, etc., and for operational use by the transportation director and his or her staff. Both pupil listings, of a variety of kinds including file cards, and fleet utilization reports are available. Part of the output at this stage is a bus pass for each transported pupil ready for mailing, identifying the stop, school, bus and the scheduled calling time for that stop.

Now for the first time the guesswork is removed from the pupil transportation routing and scheduling process, officials have at their fingertips up-to-date records that list the pupils that are authorized transportation, where they reside, what schools they will attend, their bus stop assignment, and the mode of transportation required by each. As may be apparent, in the process of executing TRIPS, it is possible for the transportation director to exert close regulation and control over the transportation function. The system has the flexibility to accept and adhere to a wide variety of parameters and still produce good, workable bus routes and time schedules.

More importantly, stops and routes are optimally safe. The load factors for vehicles are preplanned by the transportation director with the assurance that the computer will not overload any bus. The time of travel for each route is dictated to the minute and varied by school, locale, and road conditions. The average speed is regulated by individual routes taking account of traffic densities and road conditions encountered by each vehicle. Resident side pickup is built in on roads too hazardous to cross.

Probably the greatest long-range potential of the TRIPS system, though it takes the form of serendipity, is its ability to produce a variety of alternative routing and scheduling configurations from the same basic data. What this means, in practical terms, is that the transportation director, other school administrators and school board members, if necessary, can have for review and analysis several alternative solutions to given problems related to the operation of the school district--including some beyond the area of pupil transportation.

'73 included the variation of bus load limits and live load time constraints, use and non-use of resident side pickup on selected arteries, and step-wise staggering of school opening time to enable bus routes serving adjacent attendance districts to be consolidated into trips serving several schools. Presentation of alternative solutions* as part of the TRIPS service in the form of optional versions of computer run bus routes and time schedules enables the educational administrators in the districts to consider the safety, educational, administrative and financial impacts of the changes they contemplate making prior to making them.

On the criteria of safety and effectiveness, TRIPS '73 got high marks.

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* There are several problem areas outside transportation where alternative presentations using the TRIPS system would seem to have potential. These include pupil - school assignment, attendance re-districting, new school site selection, and old school phase-out decisions.

Economy The economic impact of TRIPS 1973 in the various pilot districts was estimated by the staff of the Bureau of Pupil Transportation in the New Jersey Department of Education with the assistance of the individual school districts. Salient parts of these estimates are reported below.

Estimated Savings and Economies

| Type of District | Changes | Savings |
|---|---|---|
| Regionalized, five high schools, 198 square miles | 600 new students accommodated without additional routes. | $28,000 |
| Built-up elementary in Township | With increase of students equal to two more routes, number of routes was reduced by one. | $19,000 |
| Rural elementary, 20% developed | Saved four routes. | $21,000 |
| Suburban elementary, many newcomers | With a crucial split-session issue alive, school would not have opened on time without TRIPS | $30,000 |
| Large K-12, 40% developed, 7,000 transported | Number of routes needed was reduced by 27. | $63,000 |
| K-12, mountainous terrain | Number of routes needed was reduced by 7. | $29,000 |
| K-12, small in area and pupil population | Two earlier computerized bus scheduling attempts by a commercial firm had failed. TRIPS was successful, resulted in route reduction. | $13,000 |

| Type of District | Changes | Savings |
|---|---|---|
| Dual-jurisdiction, local elementary, regional high school. | Route reduction was realized | $17,000 |
| Medium-size elementary, 5,000 transported | Less than full scale participation, still experienced a route reduction | $12,000 |
| K-12, medium-size, 4,000 transported | Route reduction was realized | $15,000 |
| Large area regional high school, two high schools, 250 square miles | Despite need to route ninth graders manually, route reduction was realized. | $17,000 |
| K-12, large and rural | TRIPS program absorbed marked increase of student body into existing routes and fleet, where otherwise increase in routes, vehicles and personnel would have been necessary. | $50,000 |
| K-12, urban, 7,000 students, less than half transported. | Savings in routing was experienced | $11,000 |
| K-8 | Opened a new school without problems, same fleet size, handling increase that otherwise would have called for two routes more. | $ 9,000 |
| K-12, rural, thinly populated, 2,000 transported | Reduction of one route below previous year, while student body increase was equivalent of two routes. | $14,000 |

| Type of District | Changes | Savings |
|---|---|---|
| K-12, resort town, 2,000 pupils, 1,000 transported | Reduction of one route, during increase of student body by one route | $ 6,000 |
| JHS-SHS, regional, mostly rural | Staggered scheduling of 20 minute opening time. If adopted would have saved $20,000 more in transportation, with number of buses needed reduced by 10. Change planned for 1974-75. Fleet size constant for 1973-74 with student increase equal to two routes. | $ 9,000 |
| K-8, mostly rural | Route reduction experienced. | $10,000 |
| WIDELY VARIED DISTRICTS* | ELIMINATION OF 68 ROUTES, MINIMUM | $373,000 |

CURRENT STATUS OF THE TRIPS SYSTEM

There are several respects in which TRIPS needs to be subjected to further improvement so that its fullest possible potential may be realized. At the conclusion of TRIPS '73, the system was seen as a product of responsible research and development needing to be further developed to the advanced prototype stage. The TRIPS scheduling and routing system had been thoroughly pilot tested. Formative evaluation, as expected, had pointed to certain limitations and deficiencies, and to the improvements needed to rectify them. At the time of this writing, much of the necessary development has been completed, and systems refinements to satisfy present needs have been incorporated into the systems design. Other refinements, as in the case of any innovation which uses computer and telecommunications technologies, await further

* The four districts with which participation was not fully realized are described in Appendix A.

developmental effort. While those developments continue, though, there now is on line an operating system for TRIPS '74.

A profile of TRIPS '74 from one perspective might see it having most of the features TRIPS in due course will have--say 3/4 to 4/5 of the ultimate system. As a consequence, field testing and summative evaluation of TRIPS '74 will attempt to put into focus answers to such questions as those that follow:

- Has the system realized the goals and objectives set for it?
- At what criterion levels has it or has it not done so?
- To what extent are further refinements and improvements called for? In what directions should further development be pursued?
- In what parts of the system do feasible refinements show the potential of highest gain? In what order of priority should they be dealt with?
- Can viability be attested with sufficient confidence to justify general availability?
- What steps if any are called for to mount dissemination and diffusion efforts so the availability of the service will match the extent of the need?

As may be apparent, the successes of TRIPS '73 do not afford the luxury of allowing TRIPS '74 to ride on its laurels. Much challenging and exciting work needs to be accomplished for the performance fully to meet expectations, especially those of the "performers." TRIPS '75 will likely be more strikingly different from TRIPS '74, than that is from TRIPS '73.

Two cases in point on the untravelled "roads" on the TRIPS "map" of the future will help show the nature and scope of the present challenge,

and some of the directions changes might take before the Nation's Bicentenniai year is reached.

A large number of contiguous school districts, as an example, an entire county or a consortium of school districts engaged in cooperative educational services, should be the subject of an exercise to test the ultimate level of savings possible through large scale multi-district bus scheduling and routing. One might expect that *significant, additional improvements would be possible in the combining of bus routes into multiple-route bus trips, in increasing the hours of bus-use through modestly staggering the opening and closing hours of schools in adjacent districts, in the joint accommodation of transportational and educational needs of special education pupils, etc.* Preliminary tests of the idea have made it seem highly probable that application of the TRIPS system to a large area enveloping a number of school districts would open dramatic opportunities both for cost economies and administrative effectiveness not possible to achieve at the individual school district level. Such a preliminary finding needs to be subjected to thorough-going test.

A second, even more interesting TRIPS road waiting to be traveled leads to possible help for the chief school officer and board of education as they and their communities continue to cope with new populations and begin to cope with the downward trend lines of births and of school-age cohorts of children. Do we close an elementary school or redistribute pupils to balance school loadings? What school would it be best to close, or convert to other purpose? How should the pupil bases for the remaining schools be built? Where should a new school be sited? Which of several alternative changes would be preferable? Answers to these kinds of questions might be brought forward through a simulation model built on data already available in TRIPS. Such a model could be developed in a way to make it feasible to use results from it in the unbiased, dispassionate consideration of background information

on the basis of which knowledgeable decisions could be taken--whether those decisions were to have a direct bearing on school operation or take the form of more general policy. It would seem to be fortunate serendipity were the TRIPS system proven to be effective both in helping build routes and schedules to get children to and from school, and as well in helping decision makers in their determinations of the schools to which the children might best be brought. There has not yet been an opportunity to give this set of ideas even a preliminary test, but the time is certainly not far off when doing so will more likely be necessary than just desirable. Success in such a test would be measured by whether decision makers were enabled to "play" the "what if" game in a way to help bring reasonable solutions to real world problems.

ANNOTATED REFERENCES

Educational Testing Service, Final Report for a Pilot Project to Establish the Possibles Educational, Safety, and Economical Benefits of School Bus Scheduling, Princeton, New Jersey: Educational Testing Service, 1973.

This report, 160 pages, is a comprehensive review of the pilot TRIPS project, and of its principal outcomes, findings, and recommendations. Details of project operations are given as are profiles of the participating school districts.

Educational Testing Service, User Guide to TRIPS, Princeton, New Jersey: Educational Testing Service, 1974.

This manual, used in orientation and training and as a reference, spans all the component elements of the TRIPS system, and provides general information. Among others, it includes sections on Transportation Philosophies, Basics of Data Processing, District Map, Data Collection, Bus Stops, Pupil Rosters, Bus Routes, Update Routines, and Reports. The manual is issued in a looseleaf binder and is kept current through addenda released as completed.

Educational Testing Service, TRIPS-for Savings, Princeton, New Jersey: Educational Testing Service, 1974.

A brief orientation to TRIPS in the form of a slide-tape presentation, includes salient characteristics of the system and very general coverage on the why of TRIPS and on what it does. Running Time: 8 minutes

Educational Testing Service, A Twenty-Minute TRIP, Princeton, New Jersey: Educational Testing Service, 1974.

A two-part slide-tape presentation (8 and 12 minutes, respectively) that describes at the general level how TRIPS operates, the central importance of the person to person interactions, where the computer is brought in as an aid, what some of the products look like, and what results might be expected. Running time: 20 minutes.

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*Inconclusive Results from TRIPS '73*

| Type of District | Problems | Future |
|---|---|---|
| An urban district with an interest in improving transportation of special pupils. | Need for entering agreements for contracted routes early and limited amount of information available at that time on the handicapped pupils to be transported made service available only marginally useful. Routing was done but neither savings nor benefit could be demonstrated. | District not taking part in TRIPS '74. |
| A small, completely rural and residential K-8 district. | Route review was held up because of a budget defeat; transportation budget information was delayed until within a month of school opening. In addition, special routing requirements were too severe to be accommodated within a systems approach. | Even with manual construction of the routes, preparation by TRIPS of final reports for use in route operation "made participation worth the effort." District is participating in TRIPS '74. |
| A regionalized and extended K-12 district of several small communities | Sizable school population changes occurring close to opening of school made it necessary to blend TRIPS-produced routes with routes produced manually in the district. | Participation in TRIPS '74 includes consideration of other administrative functions in the execution of which TRIPS may be able to assist. |
| A medium K-12 mostly rural district with large planned community under development | Turnover in staff in the district at a crucial point, and a decision to construct routes manually with TRIPS serving as a parallel simulation limited the outcomes. | Using TRIPS '74 to help build an improved transportation system for the district is already well on the way. |